Journal of Applied Health Sciences and Medicine, 1 (2) (2021) 01-11

The role of palm oil in nutrition: myths and facts

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Received: 29 May 2021 Accepted: 15 June 2021

Abstract

Palm oil is a vegetable oil with a high content of saturated fats. It is obtained from the plant *Elaeis guineensis* or palm from Guinea, originating in Africa. It is fast growing and aggressive, requiring large spaces for growth. Harvesting palm oil from the mesocarp of the fruit goes back 5000 years. This comprehensive review will study palm oil, its uses, and its implications for health as well as the nutritional implications of smaller and larger components derived from palm oil. The intense exploitation of palm oil has contributed to the greenhouse effect and climatic change by the destruction of palm oil plantations, almost taking the species to extinction.

Keywords: Palm oil, saturated fatty acids, palmitic acid.

1. Introduction

Recently, there has been much controversy in the media about palm oil. On one hand, palm oil has been lauded for its high industrial value; on the other, it has been reviled by health professionals who specialise in nutrition. The controversy has focused on the fact that many supermarket chains are eliminating palm oil from all products carrying their brand label. These companies are negotiating possible alternatives with their suppliers to remove this ingredient from its production lines due to its high fat content [1]. Not all vegetable oils and fats are equal, and their effects on the consumers' health are also different. Some are classified as healthy, while others are associated with increased risks of harmful disorders. For this reason, the European Union's standard on food labeling has made it clear that the use of "vegetable oils" is to be avoided; instead, the origin of these oils and fats must be specified on the labeling. Among the main suspects hidden under the name "vegetable oil" is palm oil and its derivatives.

Palm oil has never enjoyed a good reputation, and everyday there is more evidence against it. What is more, palm oil production and its implications on health are matters that have political,

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environmental and social ramifications. These have been studied and reported recently by the European Food Safety Authority. The use of palm oil by the food industry is increasingly being criticized for its alleged negative effects on human health and the environment. These include deforestation and the loss of natural habitats of endangered species such as the orangutan and the tiger. Sumatra, is well known as a contributor to the emission of greenhouse gases [8]. Growing demand for palm oil from large food, cosmetics and agrofuel corporations is driving the large-scale destruction of peatlands and rain forests in Indonesia.

The problem with this fat that it has a 45% palmitic acid content. According to international guidelines, the intake of saturated fatty acids above 10% of the total energy within a balanced diet does not have any detrimental effect on human health, specifically on the prevalence of cardiovascular diseases or cancer [9].Numerous scientific, medical, and food societies question its use for human nutrition, because habitual consumption of this saturated fatty acid can lead to an increase in LDL cholesterol, which tends to accumulate in the arteries, causing the development of atherosclerosis that can cause strokes and heart attacks, according to data from the Spanish Heart Foundation. Nevertheless, after a series of studies the Italian Nutrition Foundation has concluded that there is really no evidence to show that the consumption of palm oil is harmful to health when compared with other fats rich in saturated fatty acids [9].

2. Composition and properties of vegetable oils

Edible vegetable oils are food products consisting mainly of fatty acid glycerides obtained from vegetable sources. They may contain small amounts of other lipids, such as phosphatides, unsaponifiable constituents and free fatty acids that are naturally present in fats or oils. Virgin oils are obtained, without modification, by mechanical procedures and by the application of only heat. They are purified by washing, sedimentation, filtration and centrifugation processes only. Cold pressed oils are obtained without the application of heat. In the same way, they may have been purified by washing, sedimentation, filtration and centrifugation [2].

Palm oil is obtained from the fleshy mesocarp of the oil palm fruit (*Elaeis guineensis*], which is fleshy orange due to the presence of carotenoids [3]. Figure 1 shows an image of a palm plantation.

Figure 1. Image of a palm plantation. [1]

Elaeis guineensis jacq. is the most common African oil palm. It has a very robust stem and can reach up to 30 m in height. Its leaves produce an exudate called palm sage or palm wine. The fruit is a drupe that produces two types of oil: palm oil is obtained from the mesocarp and almond oil is obtained from

the grain. Red palm oil is the main source of domestic or edible oil in Africa. It is fractionated and refined in products such as palm olein and super palm olein. Palm olein is the liquid extraction obtained from the fractionation of palm oil (described above). Palm stearin is an extraction with a high melting point obtained from the fractionation of palm oil (described above).

Palm Super-olein is the liquid extraction obtained from the fractionation of palm oil (described above) produced by a specifically controlled crystallization process in order to obtain an iodine number of 60 or more. Palm oil is the vegetable oil with a high production volume. second only to soybean oil. The fruit of the palm is slightly red, just like unrefined bottled oil. Raw palm oil is a rich source of vitamin A [4) and vitamin E [5]. The palm is native to West Africa, where the oil has been produced for more than 5,000 years. Later it was introduced in America and Asia. Malaysia is now the world's largest producer of palm oil and its derivatives. Colombia and Ecuador are also important sources.

The unsaturated fatty acids that are part of the triglycerides in palm oil are: oleic (36-44%) and linoleic (9-12%). Among the saturated fatty acids, there are palmitic (39.3-47.5%) and stearic (3.5-6%) [5]. Table 1 shows the composition of palm oil. Table 2 compares the composition or molecular weight of fatty acids in vegetable oils [6,7].

Acid	% Fatty Acid Weight
C12:0 Lauric	0,2
C17:0 Myristic	0,9
C16:0 Palmitic	42,3
C18:0 Stearic	5,4
C18:1 Oleic	40,5
C18:2 Linoleic	10,3
C18:3 Linolenic	0,4

Table 1. Composition of palm oil (modified from 6).

Oils	12:0	14:0	16:0	18:0	18:1	18:2	18:3	22:1	Other
Corn	**0,0**	**0,0**	**10,0**	**2,6**	**34,0**	**47,9**	**1,05**	**0,0**	**4,5**
Cotton seed	**0, 0**	**1,2**	**25,4**	**2,9**	**16,0**	**54,0**	**0,5**	**0,0**	**0,0**
Crambe	**0,0**	**-**	**2,0**	**0,9**	**18,9**	**9,0**	**6,9**	**58,8**	**3,5**
Flax	**0,0**	**-**	**5,3**	**2,7**	**21,6**	**16,5**	**50,9**	**0,0**	**3,0**
Peanut	**0,0**	**-**	**10,2**	**5,1**	**48,0**	**30,6**	**0,8**	**0,2**	**5,1**
Cartamus	**0,0**	**0,1**	**7,7**	**2,5**	**12,1**	**77,9**	**0,1**	**0,0**	**0,0**
High oleic cartamus	**0,0**	**0,0**	**4,9**	**5,0**	**76,3**	**15,0**	**0,0**	**0,0**	**0,0**
Sesame	**0,0**	**-**	**11,4**	**4,9**	**48,8**	**33,9**	**0,0**	**0,0**	**1,0**
Soy	**0,0**	**-**	**10,2**	**4,1**	**23,5**	**53,7**	**7,0**	**0,0**	**1,5**
Sunflower	**0,0**	**-**	**5,7**	**4,1**	**20,5**	**67,3**	**0,6**	**0,0**	**1,8**
Babassu	**0,0**	**16,0**	**7,4**	**4,0**	**14,0**	**2,2**	**0,0**	**0,0**	**11,9**
Coconut	**44,5**	**15,8**	**9,0**	**2,0**	**6,6**	**1,8**	**0,0**	**0,0**	**17,3**
Palm	**47,5**	**1,5**	**39,2**	**5,2**	**45,0**	**9,0**	**4,7**	**0,0**	**0,0**
Neem	**0,9**	**0,2**	**14,9**	**19,3**	**55,5**	**9,1**	**0,0**	**0,0**	**1,0**
Jatropha	**0,0**	**-**	**10,9**	**3,9**	**45,0**	**37,2**	**0,2**	**0,2**	**2,6**

Table 2. Composition or molecular weight of fatty acids in vegetable oils (modified from 7).

In addition, palm oil is rich in natural antioxidants such as beta-carotenes (62%) and alpha-carotenes (38%). Both are precursors of vitamin A and tocotrienols that make up more than 80% of the total of vitamin E, palm oil being the only edible vegetable oil that contains it [5]. The use of palm

oil is fundamentally at the culinary level. It is preferably used as a frying or dressing oil, often added to margarine, custard, pizzas, soups, pasta or ice cream, where, on many occasions it appears as "vegetable fat" or "vegetable oil". Equivalent derivatives of cocoa oil can also be made from palm oil [5]. The problem with using palm oil for frying is that when heated, reactions such as oxidation, hydrolysis, isomerization, and polymerization cause large amounts of volatile compounds and of monomerized and polymerized by-products, some of which are potentially toxic and are known as harmful to human health [10]. Palm oil has a high smoke point, that is, the temperature at which a fat or oil produces a continuous tuft of smoke. It is an important indicator of the ability to fry a fat. Since palm oil has a smoke point higher than 200ºC, it is a good candidate for frying at any temperature [11], although if the oil is used several times the smoke point drops and volatile compounds will be emitted at lower temperatures with the consequent toxicity. Good kitchen ventilation is desirable in these circumstances to reduce the impact of volatile compounds [12]. For industrial uses palm oil is used as a raw material in the production of biodiesel fuel, or in the preparation of animal feed. Its derivatives are also found in many products: lipsticks, pharmaceuticals, creams, toothpastes and plastics, and in detergents: soaps, bath gels, etc. [5]. For these reasons, it is easy to understand why palm oil is a raw material of great interest for industrial development.

3. Palm oil in human nutrition.

Historically, dietary fats and oils have been the subjects of debates regarding the type and quantity of oil most desired for use in daily diets, as well as its role in regulating body weight and its importance in the etiology of chronic diseases [13]. Palm oil is easily digestible and absorbable. In human nutrition experiments it was found that diets with palm oil produced cholesterol reduction. In experimental studies with animals, it was found that palm oi inhibits arterial thrombosis, does not produce effects on blood pressure, does not promote arteriosclerosis and increases the blood flow of coronary arteries. Likewise, it has been observed that palm oil significantly decreases the presence of cancerous tumors. In addition to being rich in beta-carotene and vitamin E (food additives and antioxidants), palm oil is effective in inhibiting oral cancer in animals. The tocotrienols that palm oil contains in abundance, and that are not found in other edible oils, play a fundamental role in blood coagulation and in the suppression of cholesterol production [14].

Palm oil as an energy source is considered essential in infant feeding, like coconut oil, in developing countries. West African societies recognize palm oil as a positive food source, and it has been used as a primary source of dietary fat in many stews, sauces, and soups [12,15]. However, scientific literature tells us that there is a relationship between the components of palm oil and the development of cardiovascular diseases. Since palm oil is a solid and semi-solid oil at room temperature, it is used as a substitute for other vegetable oils that contain trans acids in its composition that increase the risk of hypercholesterolemia. The use of palm oil compared to other oils such as sunflower, olive, or soybean did not show great differences in the changes in LDL, HDL or total cholesterol levels. The antioxidant properties of palm oil due to its content of carotenoids and tocotrienols suggest that it would be the oil of choice for human consumption [16]. Despite its high content of palmitic acid, a saturated fatty acid, some authors consider it as an undesirable oil and its participation in diseases such as obesity, type 2 diabetes mellitus, cardiovascular diseases and cancer is considered important [17]. Nevertheless, palm oil has positive nutritional properties: it is anti-hemorrhagic, anti-arteriosclerosis, anti-cancer, antihypertensive and anti-infective [4].

4. Palm oil and cardiovascular diseases

Palm oil contains a large amount of saturated fat compared to most vegetable oils; however, studies have not found any negative effect on blood lipids. Over a two-week period, the effects of consuming palm oil were compared to any vegetable oil low in saturated fat or partially hydrogenated

vegetable oil containing trans-fat and animal fat. The data were pooled using a random effects meta-analysis [18]:

1. Palm oil significantly increased LDL cholesterol by 0.24 mmol/L compared to vegetable oils low in saturated fat. This effect was seen in randomized trials, but not in non-randomized trials.

2. Among the randomized trials, palm oil increased HDL cholesterol by 0.02 mmol / L when compared to vegetable oils low in saturated fat, and 0.09 mmol / L compared to oils containing trans-fat.

Therefore, the consumption of palm oil in humans produces a higher concentration of LDL cholesterol levels compared to vegetable oils low in saturated fat and higher HDL cholesterol levels than oils containing trans-fat. Thus, the effects of palm oil on blood lipids are expected from any oil whose content in saturated fats is high, therefore it is considered appropriate to reduce the use of palm oil in the diet and replace it with low vegetable oils. saturated and trans-fat [18]. Other studies defend the use of palm oil in the daily diet since they believe that there is no scientific evidence to show that it increases cholesterol levels and arteriosclerosis due to its high content of vitamin E, and that it is a natural inhibitor of the synthesis of cholesterol [19].

5. Palm oil and vitamins A and E

Due to its high content of phytonutrients such as carotenes, tocotrienes, tocopherols and coenzyme Q10, palm oil has nutritional properties and great oxidative stability. Food and toxicological studies have shown that palm oil contains sufficient amounts of vitamin A and beta-carotenes, being reasonably stable to be heated at any temperature without presenting adverse effects. As vitamin A is involved in the maintenance of the function [13], [20]. Vitamin A deficiency causes serious health damage such as mortality or xerophthalmia, as well as night blindness [21]. To combat vitamin A deficiencies, the diet must be diversified, supplemented with vitamin A and food fortified. Dietary diversification aims to educate populations at risk of consuming sufficient amounts of micronutrients [22]. Recently, the fortification of vegetable oils with vitamin A has been suggested as an intervention strategy to increase the intake of vitamin A [23]. The problem with this lies in the loss of stability during domestic storage of vitamin A in commonly used oils such as soy [24,25]. For this reason, the convenience of vegetable oils rich in polyunsaturated fatty acids was considered as a food vehicle for fortification of vitamin A, such as palm oil rich in palmitic acid and oleic acid [26, 27].

6. Palm oil and its relationship with cancer

The carotenoids contained in palm oil fight vitamin A deficiency. However, they can also protect against cardiovascular diseases and be suitable for use in breast cancer [28,29], lung, liver and colon as they suppress growth of various cancer cells [30,31,32,33].

Squalene is a very valuable triterpene found in shark liver oil, and it is present in small amounts in palm oil, it is a transmitter of oxygen and helps cardiovascular health. Studies carried out on rodents have shown antitumor activity, since it suppresses the hyperproliferation of cancer cells and exhibits radioprotective effects [30,34]. The phytosterols found in raw palm oil are beta-sitosterol's, Campesterol and stigmasterol, have been shown to reduce cholesterol, in addition to improving immune functions and possessing properties against cancer [30]. The phenolic compounds present in palm oil also have anti-cancer and cardioprotective properties [30]. The phospholipids found in palm oil are phosphatidylcholine, phosphatidylethanolamine, phosphatidylinositol, and phosphatidylglycerol, are part of biological membranes and lipoproteins, and are essential for improving brain function, energy resistance, and structural integrity of cells, as well as to facilitate the digestion and absorption of nutrients [30]. The table 3 contains a global summary on palm oil.

FATTY ACIDS [average values g / 100g) [35]

40-50% <u>Saturated fatty acids</u>

- C16: 0 Palmitic 43.5 g / 100g
- C18: 0 Stearic 4.3 g / 100g
- C14: 0 Myristic 1 g / 100g
- C12: 0 lauric 0. 1 g / 100g

37-46% <u>Acids fatty monounsaturated</u>

- C 18: 1 Oleic 36 g / 100g
- C16: 1 Palmitoleic 0.3 g / 100g
- C22: 1 Erucic 0.1 g / 100g

9-10% <u>Polyunsaturated fatty acids</u>

- C18: 2 Linoleic 9.1 g / 100g
- C 18: 3 Linolenic 0.2 g / 100g

VITAMINS [1]

- Vitamin E (Tocopherols, Tocotrienols)
- Carotenes precursors of Vitamin A

VIRGIN AND REFINED PALM OIL

- **VIRGIN**
  - It comes from the flesh of the palm fruit.
  - Contains beta-carotenes and vitamin E in a high proportion, which gives it antioxidant properties that are very beneficial for health (vision, aging ...) [36].
- **REFINED**
  - Oil is obtained by subjecting the seed of the palm fruit to refining, bleaching and deodorizing processes that require temperatures above 200ºC.
  - Oil ontains potentially carcinogenic products: glycidol, monochloropropanediols and their esters.
  - Oil does not contain Vitamins A and E, it loses them in the process.
  - Oil is used massively in the food industry, being present in many foods [36].

HEATING TO HIGH Tª

When heated to Tª > 200ºC oxidative, hydrolytic and thermal reactions take place.

PROPERTIES GENERATED:

- Glycidol, Monochloropropanediols (2- MCPD and 3- MCPD) and their esters.

Glycidic esters and 3-MCPD are classified as potential carcinogenic agents by the IARC (International Agency for Research on Cancer) [37,38].

PROPERTIES LOST:

- Tocopherols and Tocotrienols: Vitamin E
- Carotenes: Vitamin A
- It is mainly due to saturated FA: Palmitic and Stearic, semi-solid or solid at room temperature (difference with olive or sunflower oil) [39].
- To be used in the food industry, it undergoes the refining process.

PROPERTIES OF INTEREST IN THE FOOD INDUSTRY

- It is mainly due to saturated FA: Palmitic and Stearic, semi-solid or solid at room temperature. (difference with olive or sunflower oil) [39].
- As used in the food industry, palm oil undergoes refining processes.

PROPERTIES OF INTEREST: [39,40].

- In its refined form, palm oil does not add flavor, odor, or reddish color.
- Adequate consistency and smoothness.
- It is very stable and does not get rancid or rust easily.
- Maintains its organoleptic properties at high temperature.
- High-yield production (produces ten times more oil per unit area than other oilseed crops)
- Low price.

FOODS IN WHICH PALM OIL IS FOUND

- Dairy products: custard, melted cheeses, "petisuis".
- Margarines, butters and spreads: melts at high temperature, saturated fat makes spreading easier.
- Bakery products, ice cream and industrial pastries: as a substitute for hydrogenated fats or butter.
- Pre-cooked products
- French fries, pizzas, sauces, dessert toppings ...

LEGAL ASPECTS IN THE LABELING EU REGULATION No. 1169/201 [41].

- In all foods marketed before December **13, 2014**, with the label "vegetable oils" or "vegetable fats", since that date the specific origin of the vegetable oil must be indicated, that is, palm oil.

There may still be difficulties with identification!!

- There may be foods marketed prior to that date that are not identified.
- Palm oil derivatives used as flavorings, emulsifiers, humectants and colorants, are difficult to identify. There are many different names for these derivatives.

PALMITHIC ACID IN INFANT MILK?

- BREAST MILK**:** Palmitic in beta form is the most abundant saturated FA (25 % of FA). It favors the absorption of fats and calcium and the development of the microbiota.
- INFANT MILK**:** Alpha palmitic in a proportion similar to that of breast milk. To improve the absorption and microbiota properties, beta-palmitate can be added [42].
- The Spanish Society of Pediatrics states *"In children under 2 years of age, the consumption of palmitic acid is important, since its content in the body is high and has specific functions. For this reason it is present in infant formulas. It is an essential ingredient. Palm oil is an important source of palmitic acid"* [43].
- The European Food Health Authority EPSA has recently published *"infants and children exceed the tolerable daily intake of MCPD.* [44].

HEALTH EFFECTS

Based on a review of the scientific literature (Medline) and reports from the Medical and Nutrition Societies [44-46]:

- Due to its saturated fat content:

- There is evidence that high consumption of saturated fat is a risk factor for cardiovascular diseases.
- There is no evidence that the consumption of palm oil or palmitic acid has specifically more negative effects on health compared to other foods rich in saturated FAs
- The WHO recommendation for people over 2 years of age:
  - Total fat consumption less than 30% of the total caloric intake.
  - Saturated fat intakes less than 10% of the total [44,45].

- Because of its glycidol and MCPD content, generated in refining:

- The Spanish Agency for Consumption, Food Safety and Nutrition (AECOSAN) of the Ministry of Health, Social Services and Equality [4] accepts the maximum limits of these potentially carcinogenic products established by the European Food Safety Authority (EFSA) in the 2014 Recommendation / 661 / EU [16].

CONCLUSIONS

Palm oil's **"**good properties" are the basis of its wide use in the food industry. It is present in many foods, and therefore its consumption may be too high.

- From the nutritional point of view, in a balanced diet with a saturated FA intake adequate to the recommendations, there is no evidence that it increases cardiovascular risk or that it is worse than other animal or vegetable saturated fats.
- The main problem does not relate to nutrition in if itself but to the generation of potentially carcinogenic in the refining process. EFSA continues to work on the setting of the maximum limits for these products which are also cumulative and are also generated in the refining of other foods.

Therefore: *Using an adequate diet based on natural foods, with fewer industrial or processed products, is beneficial for health".*

"It is the job of the health authorities to establish regulations and protocols so that industrially obtained foods are healthy and nutritionally adequate".

Tabla 3. Global summary on palm oil [35-46].

7. Conclusions

Although there is still reluctance to use palm oil due to its high content of saturated fats that clog arteries, more and more authors defend its use for culinary and industrial applications and highlight its beneficial effects for health. Health professionals, especially dietitians and nutritionists, have key roles to play in educating consumers about the model of eating in a healthy way, including the appropriate use of these oils. If palm oil-producing industries are prioritized and supported, not only will a food product, raw materials, and a sustainable income be obtained, but also provide employment for the development of the nation. Many of the studies reviewed here were conducted to find innovative solutions that demonstrate that palm oil is suitable, evaluating its benefits and impact on human health, on industry and on the environment. Palm oil is superior to other oils such as soybean for vitamin A enrichment programs to supply sufficient quantities. However, it is advisable to look for

other types of dietary sources of essential fatty acids, fortified in vitamin A, other than palm oil, because when the period of domestic storage of vegetable oil exceeds one month, the peroxide value increases beyond the acceptable level of 10 meg O2/kg regardless of the degree of saturation of fatty acids. Overall, the reviewed studies establish palm oil as a balanced and nutritious oil, and accept it as being as good as olive oil. Palm oil's positive attributes and its compatibility in many food formulations are recognized. Therefore, palm oil will continue to play a prominent role in the oil and fat market with high consumer acceptance [30].

Acknowledgment. The authors would like to thank the anonymous reviewers.

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